

FINAL EXAM FORMULA SHEET



Miscellaneous Formulae

Please note- it is up to you to understand what each formula means, and it is also up to you to know which formula you need to use in a given situation. We (the Course Staff) will not be able to answer any questions about these formulas during the Exam.

$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i$	$s_X^2 = \frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2$	$s_X = \sqrt{s_X^2}$
$IQR = Q_3 - Q_1$	$\text{range}(X) = \max\{X\} - \min\{X\}$	
$0 \leq \mathbb{P}(A) \leq 1$	$\mathbb{P}(\emptyset) = 0$	$\mathbb{P}(\Omega) = 1$
$\mathbb{P}(A^c) = 1 - \mathbb{P}(A)$	$\mathbb{P}(A \cup B) = \mathbb{P}(A) + \mathbb{P}(B) - \mathbb{P}(A \cap B)$	
$\mathbb{P}(E F) = \frac{\mathbb{P}(E \cap F)}{\mathbb{P}(F)}$ provided that $\mathbb{P}(F) \neq 0$		
$\mathbb{P}(E F) = \frac{\mathbb{P}(F E) \cdot \mathbb{P}(E)}{\mathbb{P}(F)}$ provided that $\mathbb{P}(E) \neq 0$ and $\mathbb{P}(F) \neq 0$		
$E \perp F$ if any of: $\mathbb{P}(E F) = \mathbb{P}(E)$; $\mathbb{P}(F E) = \mathbb{P}(F)$; $\mathbb{P}(E \cap F) = \mathbb{P}(E) \cdot \mathbb{P}(F)$		
$0! = 1$	$\mathbb{P}(E) = \mathbb{P}(E \cap F) + \mathbb{P}(E \cap F^c)$	
$n! = n \times (n-1) \times \dots \times 2 \times 1$	$(n)_k = \frac{n!}{(n-k)!}$	$\binom{n}{k} = \frac{n!}{k! \cdot (n-k)!}$
$\mathbb{P}(X = k) \geq 0$	$\sum_{\text{all } k} \mathbb{P}(X = k) = 1$	$SD(X) = \sqrt{\text{Var}(X)}$
$\text{Var}(X) = \sum_{\text{all } k} (k - \mathbb{E}[X])^2 \cdot \mathbb{P}(X = k) = \left(\sum_{\text{all } k} k^2 \cdot \mathbb{P}(X = k) \right) - (\mathbb{E}[X])^2$		

$\text{TS} = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$	$\text{TS} = \frac{\bar{X} - \mu_0}{\sigma / \sqrt{n}}$	$\text{TS} = \frac{\bar{X} - \mu_0}{s / \sqrt{n}}$
$\text{TS} = \frac{\bar{Y} - \bar{X}}{\sqrt{\frac{s_X^2}{n_1} + \frac{s_Y^2}{n_2}}}$	$\text{TS} = \frac{\hat{\beta}_1}{\text{SD}(\hat{\beta})_1}$	$\hat{\beta}_0 = \bar{y} - \hat{\beta}_1 \cdot \bar{x}$
$r = \frac{1}{n-1} \sum_{i=1}^n \left(\frac{x_i - \bar{x}}{s_X} \right) \left(\frac{y_i - \bar{y}}{s_Y} \right)$	$\hat{\beta}_1 = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^n (x_i - \bar{x})^2} = \frac{s_Y}{s_X} \cdot r$	
$\text{df} = \text{round} \left\{ \frac{\left[\left(\frac{s_X^2}{n_1} \right) + \left(\frac{s_Y^2}{n_2} \right) \right]^2}{\frac{\left(\frac{s_X^2}{n_1} \right)^2}{\frac{n_1-1}{n_1-1}} + \frac{\left(\frac{s_Y^2}{n_2} \right)^2}{\frac{n_2-1}{n_2-1}}} \right\}$		$\text{TS} \stackrel{H_0}{\sim} t_{\text{df}}$
$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 \cdot x$	$e_i = y_i - \hat{y}_i$	$\text{RSS} = \sum_{i=1}^n e_i^2$

Binomial Distribution: $X \sim \text{Bin}(n, p)$

$S_X = \{0, 1, 2, \dots, n\}$	$\mathbb{E}[X] = np$	$\text{Var}(X) = np(1-p)$
$\mathbb{P}(X = k) = \binom{n}{k} \cdot p^k \cdot (1-p)^{n-k} \text{ if } k \in S_X \text{ and } 0 \text{ otherwise}$		

Uniform: $X \sim \text{Unif}(a, b)$

$S_X = [a, b]$	$\mathbb{E}[X] = \frac{a+b}{2}$	$\text{Var}(X) = \frac{(b-a)^2}{12}$
$f_X(X) = \frac{1}{b-a} \text{ if } x \in S_X \text{ and } 0 \text{ otherwise}$		

Normal: $X \sim \mathcal{N}(\mu, \sigma)$

$S_X = \mathbb{R} = (-\infty, \infty)$	$\mathbb{E}[X] = \mu$	$\text{Var}(X) = \sigma^2$
$f_X(X) = \frac{1}{\sigma\sqrt{2\pi}} \cdot \exp \left\{ -\frac{1}{2} \left(\frac{x - \mu}{\sigma} \right)^2 \right\}$		$Z = \left(\frac{X - \mu}{\sigma} \right) \sim \mathcal{N}(0, 1)$

Central Limit Theorem for Proportions

Given a population with proportion p , define $\hat{P}$ to be the sample proportion. Then

$$\hat{P} \sim \mathcal{N} \left(p, \sqrt{\frac{p(1-p)}{n}} \right)$$

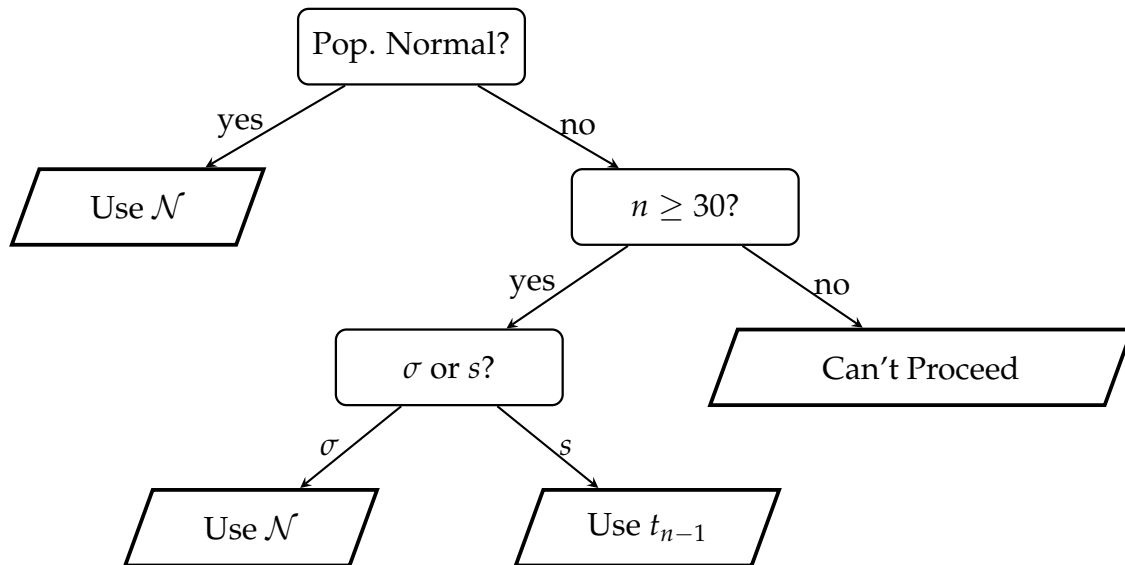
provided: **(1)** $np \geq 10$ and **(2)** $n(1-p) \geq 10$ —OR— **(1)** $n\hat{p} \geq 10$ and **(2)** $n(1-\hat{p}) \geq 10$

Confidence Intervals

$$\hat{p} \pm z^* \cdot \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \quad \bar{x} \pm z^* \cdot \frac{\sigma}{\sqrt{n}} \quad \bar{x} \pm t^* \cdot \frac{s}{\sqrt{n}}$$

$$\bar{x}_1 - \bar{x}_2 \pm t^* \cdot \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} \quad \bar{x}_d \pm t^* \cdot \frac{s_d}{\sqrt{n}} \quad \hat{\beta}_1 \pm t^* \cdot SD(\hat{\beta}_1)$$

Flowchart for the Sampling Distribution of $\bar{X}$



Assorted Coding Results

- `.ppf(q, *args)` : point-percent function. Description of arguments:
 - `q`: array_like; lower tail probability
 - `*args`: parameters of the distribution
- `.cdf(x, *args)` : cumulative distribution function. Description of arguments:
 - `x`: quantiles
 - `*args`: parameters of the distribution
- `.pdf(x, *args)` : probability density function. Description of arguments:
 - `x`: array_like; quantiles
 - `*args`: parameter(s) of the distribution